CLAIMS

1. A method of non-contact ultrasonic thickness measurement of sputtering targets having a front surface and front surface/bonded surface interface comprising the steps of:

a) securing the target to a rotating holder and rotating said target;

b) sequentially irradiating the front surface with pulses of sonic energy at a plurality of positions at normal incidence to a tangent line at a plurality of positions on the front\surface, at least one of the pulses propagating through the front surface to the front surface/bonded surface interface;

c) detecting consecutive echoes induced by said pulses of sonic energy, the echoes being reflected from the front surface and from the front surface/bonded surface interface, respectively;

d) converting the front surface echoes and the front surface/bonded surface interface echoes into corresponding electric signals;

e) determining transit time of the sound path between the front surface echoes and the front surface/bonded surface echoes based on the corresponding electric signals;

f) determining thickness data of the target by multiplying known sound velocity of the target material by one half of measured transit time, corrected for a zero offset factor;

g) electronically sending the determined thickness data to a remote controller;

h) collecting thickness data for a plurality of positions on the target;

i) analyzing the collected data and extracting the value for the minimum thickness of the target.

2. The method as recited in claim 1 wherein said sputter target is attached to a backing plate by means of bonding.

3. The method as recited in claim 1 wherein said sputter target is bonded to a backing plate to form a target assembly.

4. The method as recited in claim 1 wherein said sputter target remains attached to a rotating machining tool chuck or other specimen holder and is rotated axially symmetrically during the entire thickness measurement process.

5. The method as recited in claim 1 wherein the sonic energy propagating across the bonding surface/front surface interface is nearly normal incidence to the front surface/bonded surface interface.

6. The method as recited in claim 1 wherein said sonic energy is generated as a pulse by an ultrasonic transducer enclosed in an immersion bubbler axially symmetrically opposed to the front surface of the target.

7. The method as recited in claim 1 wherein step (b) includes coupling the rotating target with an ultrasonic transducer by a column of a non-turbulent bubble-free stream of water to the front surface of the target.

8. The method as recited in claim 1 wherein step (b) includes irradiating the target with sonic energy passing through a water column generated by an immersion bubbler.

9. The method as recited in claim 1 wherein step (b) includes impinging the target with sonic energy at substantially normal incidence to the front surface.

10. The method as recited in claim 1 wherein step (b) includes impinging the target with sonic energy in a form of short duration, MHz frequency ultrasound pulse.

11. The method as recited in claim 1 wherein the echoes are detected with a data acquisition frequency substantially non-synchronized with the RPM (revolution per minute) of the rotating target.

12. The method as recited in claim 1 wherein the echoes detected are returned at normal incidence to the surface of said transducer.

13. The method as recited in claim 1, wherein said echoes are detected from a plurality of positions for more than one revolution of target under rotation.

14. The method as recited in claim 1, wherein said the calculated thickness data sent for a plurality of positions is collected for more than one revolution of the target.

15. The method as recited in claim 1, wherein at least 100 measurement calculations based on the thickness data collected is performed.

16. The method as recited in claim 1, wherein all the data points of thickness data are merged into one sequential file.

17. The method as recited in claim 1, wherein irradiating said sputtering target with pulsed sonic energy occurs additionally along a circumferential path of constant radius constituted by a plurality of all possible positions on the target front surface encompassing the ring with the area projected into the region of deepest sputter erosion.

18. The method as recited in claim 18 wherein said a plurality of all possible positions is formed by more than one revolution of the target against a stationary source of sonic energy.

19. The method as recited in claim 1, wherein the sputter target is a hollow cathode sputter target having one of a convex and a concave front surface.

20. Apparatus for measuring thickness of a sputtering target bonded into an assembly comprising:

a transducer for sequentially irradiating a sputtering target with sonic energy and for detecting echoes induced by said sonic energy;

an enclosed immersion bubbler, encompassing the transducer, mounted axially, symmetrical with a nozzle of said bubbler at normal incidence to a surface of the target;

a thickness gauge electrically connected to said transducer and programmed to measure a sound transit time between two consecutive echoes, and programmed to calculate the specimen thickness, based on known sound velocity, transit time, and zero offset factor;

a controller electrically connected to the thickness gauge and programmed:

a) to send a trigger command to start the data acquisition;

b) to receive and calculate values of the thickness as soon as thickness data collection is completed;

c) to merge each calculated thickness value into one sequential file;

d) to send a trigger command to stop the data acquisition;

e) to analyze the data, determine and display the value for the minimum target thickness.

21. The apparatus as recited in claim 20 wherein said bubbler is physically spaced from the target front surface so as to not contact physically the front surface of the target.

22. The apparatus as recited in claim 20 wherein said bubbler includes a nozzle having an opening providing fully transparent transmission of sound energy to and from the transducer.

23. The apparatus as recited in claim 22 wherein said transducer is positioned inside the bubbler a distance from the nozzle opening to prevent receipt of an interfering echo prior to receipt of consecutive echoes from the front surface of the target and from a front surface/bonded surface interface of the target, respectively.

24. A method for making non-contact ultrasonic thickness measurement of a component of a sputter target assembly comprising the steps of:

a) securing the assembly on a mounting member;

b) providing a bubbler assembly adjacent a surface of said component, said bubbler assembly including a sonic energy irradiation means for irradiating said surface with sonic energy at a data acquisition frequency;

c) providing movement of said sputter target assembly relative to said bubbler assembly and asynchronously relating said movement relative to said data acquisition frequency;

d) sequentially irradiating the surface of said component with pulses of sonic energy passing through said bubbler assembly;

e) detecting consecutive echoes induced by said pulses of sonic energy; and

f) determining thickness of said component by determining time intervals between said consecutive echoes.

25. A method as recited in claim 24 wherein said component comprises a target, said target assembly further comprising a backing plate bonded to said target, said target having a front surface and a back surface bonded to said backing plate, said step d) comprising irradiating said front surface of said target and wherein said consecutive echoes include, sequentially, echoes from said front surface and echoes from said back surface.

26. A method as recited in claim 25 wherein said step c) comprises rotating said target assembly around a fixed position bubbler assembly.

27. A method as recited in claim 26 wherein said data acquisition frequency comprises fixed equal intervals.

28. A method as recited in claim 27 wherein said target assembly has a substantially "U" shaped cross section.

29. A method as recited in claim 26 wherein said step c) comprises varying the rotational speed of said target assembly during said measurement.

30. A method for making non-contact ultrasonic thickness measurement of a component of a sputter target assembly comprising the steps of:

a) positioning the assembly on a mounting member;

b) providing a source of sonic energy irradiation adjacent a surface of said component for irradiating said surface with sonic energy at a data acquisition frequency;

c) providing movement of said sputter target assembly relative to said source of sonic energy irradiation and asynchronously relating said movement relative to said data acquisition frequency;

d) sequentially irradiating the surface of said component with pulses of sonic energy from said source of sonic energy irradiation;

e) detecting consecutive echoes induced by said pulses of sonic energy; and

f) determining thickness of said component by determining time intervals between said consecutive echoes.

31. A method as recited in claim 30 wherein said component comprises a target, said target assembly further comprising a backing plate bonded to said target, said target having a front surface and a back surface bonded to said backing plate, said step d) comprising irradiating said front surface of said target and wherein said consecutive echoes include, sequentially, echoes from said front surface and echoes from said back surface.

32. A method as recited in claim 31 wherein said step c) comprises rotating said target assembly around a fixed position source of sonic energy irradiation.

33. A method as recited in claim 32 wherein said data acquisition frequency comprises fixed equal intervals.

34. A method as recited in claim 33 wherein said target assembly has a substantially "U" shaped cross section.

35. A method as recited in claim 32 wherein said step c) comprises varying the rotational speed of said target assembly during said measurement.